

1       **ABSTRACT**

2       The system provides improved procedures to estimate head motion between  
3 two images of a face. Locations of a number of distinct facial features are  
4 identified in two images. The identified locations can correspond to the eye  
5 corners, mouth corners and nose tip. The locations are converted into as a set of  
6 physical face parameters based on the symmetry of the identified distinct facial  
7 features. The set of physical parameters reduces the number of unknowns as  
8 compared to the number of equations used to determine the unknowns. An initial  
9 head motion estimate is determined by: (a) estimating each of the set of physical  
10 parameters, (b) estimating a first head pose transform corresponding to the first  
11 image, and (c) estimating a second head pose transform corresponding to the  
12 second image.

13       The head motion estimate can be incorporated into a feature matching  
14 algorithm to refine the head motion estimation and the physical facial parameters.

15       In one implementation, an inequality constraint is placed on a particular  
16 physical parameter—such as a nose tip, such that the parameter is constrained  
17 within a predetermined minimum and maximum value. The inequality constraint  
18 is converted to an equality constraint by using a penalty function. Then, the  
19 inequality constraint is used during the initial head motion estimation to add  
20 additional robustness to the motion estimation.